Small Business Innovation Research/Small Business Tech Transfer

High-Resolution Scanning of Sub-Surface Lunar Water with Mobile Neutron Energy Spectrometer, Phase I

Completed Technology Project (2018 - 2019)

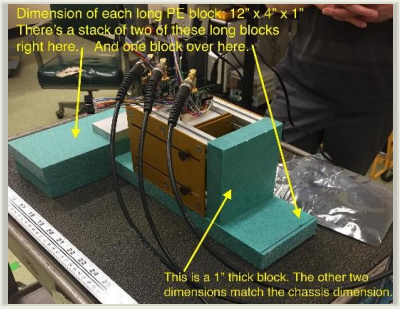
Project Introduction

This proposal describes a mobile solid-state Neutron Energy Spectrometer (NES) for lunar soil moisture determination. Cosmic-ray interactions within the lunar soil will yield secondary neutrons and protons, among other particles. The produced neutrons will travel within the soil, scattering off of materials such as hydrogen. Interactions with hydrogen will greatly reduce the energy of the neutrons, causing a measurable depression of epithermal neutrons. A measurement of the ratio between thermal and epithermal neutrons can therefore yield an understanding of the hydrogen content of the soil. A previous collaboration between Radiation Detection Technologies, Inc. (RDT), Kansas State University (KSU), and Southwest Research Institute (SwRI) has developed and produced an instrument which is capable of accurately measuring the hydrogen content of soil based on neutron emissions from the surface. The TRL 3 instrument utilizes alternating layers of neutron moderator (HDPE) and solid-state neutron detectors, with each incremental detector layer more sensitive to higher-energy neutrons than the previous. The NES can effectively scan for water at the lunar surface from zero altitude, which allows for unmatched spatial resolution. Proposed in Phase I, existing computational models will be refined and validated using the existing NES in real-world measurements. The updated computational models will be used to design a space-worthy instrument that will serve the purpose of determining the moisture content of the lunar soil. An early feasibility study will be conducted to determine what weaknesses exist in the present design in terms of survivability of the instrument under the worst of lunar conditions. In Phase II, the proposed assembly will be developed to TRL 6, wherein a roving prototype will be built and tested.

Anticipated Benefits

A compact, low-power neutron energy spectrometer (NES) would accurately measure the radiation dose to astronauts. The proposed NES can measure neutron dose to higher accuracy than existing technologies, which are bulky (7-12 kg) and can suffer poor inaccuracy (>50%) because these instruments cannot differentiate thermal, epithermal, or fast neutrons from each other. A multi-channel NES would achieve improved accuracy by including neutron energy information and reducing weight.

The original NES was developed to replace aging neutron dosimeters used aboard nuclear naval vessels for the Dept. of Defense. Surveys of ships are conducted to ensure that radiation levels do not pose a danger to the crew. A handheld NES would provide more accurate feedback and be less burdensome to the operator. Similarly, an improved dosimeter is desired at the Dept. of Energy nuclear reactor locations, such as Transient Reactor Test (TREAT) facility, where operation of the reactor varies.



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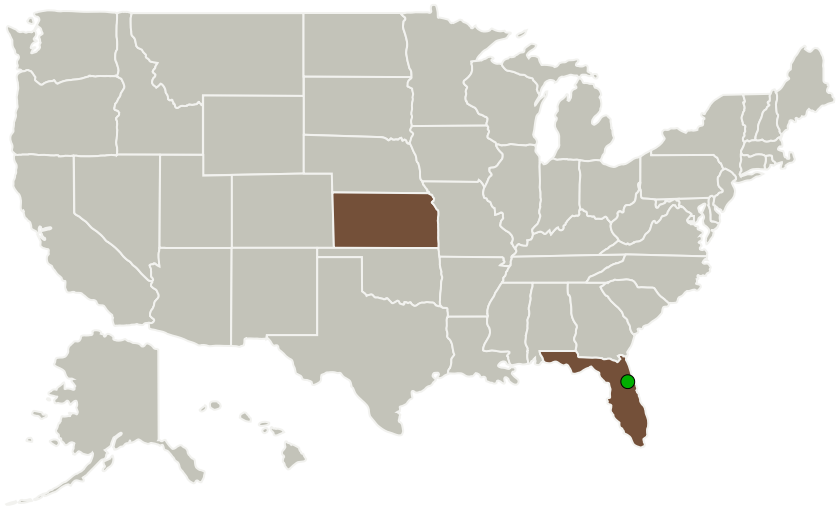
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Radiation Detection Technologies, Inc.	Lead Organization	Industry	Manhattan, Kansas
Kennedy Space Center(KSC)	Supporting Organization	NASA Center	Kennedy Space Center, Florida

Primary U.S. Work Locations	
Florida	Kansas

Project Transitions

July 2018: Project Start

February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141369)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Radiation Detection Technologies, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

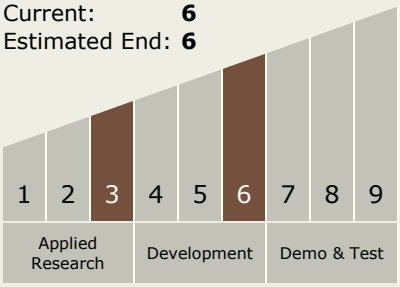
Carlos Torrez

Principal Investigator:

Steven L Bellinger

Technology Maturity (TRL)

Start: **3**
Current: **6**
Estimated End: **6**



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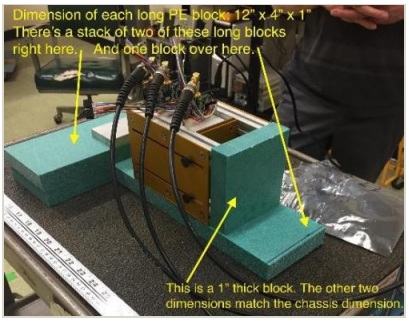
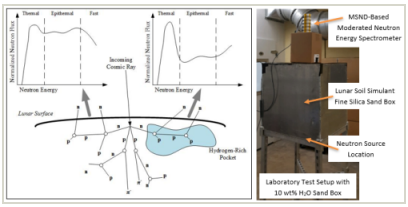
Images



Briefing Chart Image
High-Resolution Scanning of Sub-Surface Lunar Water with Mobile Neutron Energy Spectrometer, Phase I
(https://techport.nasa.gov/image/136675)



Final Summary Chart Image
High-Resolution Scanning of Sub-Surface Lunar Water with Mobile Neutron Energy Spectrometer, Phase I
(https://techport.nasa.gov/image/127268)

Technology Areas

Primary:

- TX07 Exploration Destination Systems
  - TX07.1 In-Situ Resource Utilization
    - TX07.1.1 Destination Reconnaissance and Resource Assessment

Target Destination

The Moon